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ABSTRACT

Risk Aversion and Entrepreneurship: New Evidence Exploiting Exposure to Massive Earthquakes in Italy*

This paper investigates the impact of risk attitudes on the decision to become an entrepreneur. In contrast to previous research, we handle endogeneity issues relying on an instrumental variables strategy considering as a source of exogenous variation in risk aversion the early exposure to a massive earthquake. Using several waves of the Bank of Italy Survey of Household Income and Wealth (SHIW), we find that individuals experiencing an earthquake become significantly more risk averse. Second-stage estimates show that risk aversion has a significant negative impact on the probability of becoming an entrepreneur.

JEL Classification: D81, D91, L26, C36

Keywords: entrepreneurship, risk attitudes, natural disasters, instrumental variables

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1. Introduction

Entrepreneurship is considered as the driving force of job creation, productivity, innovation and economic growth (see, for instance, Gleaser et al., 2015). Policies aimed at fostering the creation of new ventures have gained popularity both in industrialized and in developing economies. Nonetheless, there is still relevant variance in newly created firms across countries, for instance, Norway, UK and Denmark show business birth rates well above those experienced by Italy, Belgium and France (see OECD, 2014). While these differences are typically related to a number of different factors (such as demographic aspects, institutional features, etc.), recent studies have tried to understand whether some specific personality traits influence the creation of new ventures (Cramer et al., 2002; Van Praag and Cramer, 2001; Hvide and Panos, 2014; Caliendo et al., 2009).

Among these traits, not surprisingly, attitudes toward risk have received particular attention. In fact, entrepreneurship is generally connected with risk bearing. Going back to Schumpeter, entrepreneurship is defined as "*the assumption of risk and responsibility in designing and implementing a business strategy or starting a business*" (Schumpeter, 1911). Gough (1969) states that entrepreneurship "*refers to a person who undertakes and operates a new enterprise or venture, and assumes some accountability for the inherent risks*". Indeed, it is well-known that entrepreneurs typically face higher risks compared to those faced by employees. For instance, they experience a significant higher income risk and are exposed to the risk of failure compared to other types of workers (Åstebro, 2012; Åstebro et al., 2014; Evans and Leighton, 1989; Hamilton, 2000; Hartog et al., 2010; Hyytinen et al., 2013).

Given these risks, theory predicts that individuals with greater risk tolerance are more likely to enter entrepreneurship. The idea of differential risk aversion between entrepreneurs and others, already proposed by Knight (1921), has been formalized Khilstrom and Laffont (1979), who develop a model which predicts that individuals with low risk aversion will self-select in entrepreneurship, while those who are more risk averse will become employees. Nonetheless, the empirical studies trying to test this theoretical prediction have found mixed results. While some studies show a positive relationship between risk attitudes and individual's entrepreneurial choices (Cramer et al., 2002; Van Praag and Cramer, 2001; Hvide and Panos, 2014; Caliendo et al., 2009) others do not find any statistically significant correlation (Schiller and Crewson, 1997; Rosen and Willen, 2002).

These ambiguous results might be related to estimation problems, which raise doubts about the causal interpretation of the coefficient measuring the effect of risk aversion. First, in most of these studies risk attitudes are measured after occupation has been chosen; this rises reverse causality concerns as specific attitudes toward risk might have been developed endogenously by individuals after becoming entrepreneurs. Second, even when the measurement of risk attitudes does precede entrepreneurial choices (see, for example, Caliendo et al., 2009), it is not possible to establish a causal relationship since other unobservable characteristics might be correlated both to risk propensity and business entry. For instance, individuals with a favorable socio-economic background might be both more risk tolerant and more prone to become an entrepreneur as they have the security of their family resources. Moreover, there could be a substantial measurement error since the proxy for risk preferences might correspond poorly with the type of risk that matters in practice for business ventures. This would create attenuation bias.

We contribute to the literature on risk and entrepreneurship by adopting an instrumental variables (IV) estimation strategy. We rely on the idea that risk preference might change over time (Schildberg-Horisch, 2018) and following the growing literature examining the effect of natural disasters on risk aversion (Cameron and Shah, 2015; Cassar et al., 2011; Eckel et al., 2009; Hanaoka et al., 2018; Page et al., 2014), we use as an instrument for risk attitudes the individual exposure to a massive earthquake. Specifically, we exploit as a source of exogenous variation disruptive earthquakes (i.e. earthquakes categorized as at least level VII – "very strong events" – in the Modified Mercalli Intensity Scale) experienced within 50km from the place of residence.

From a theoretical point of view such experience might either induce people to become more risk averse or more risk tolerant. On the one hand, as negative shocks affect the way individuals perceive the riskiness of their environment changing the perceived likelihood that negative shocks will occur, we might expect them to become more risk averse (Gollier and Pratt, 1996; Brown et al., 2018). On the other hand, psychological theories points out that individuals might react emotionally and exhibit more risk-loving behavior (e.g., Lerner and Keltner, 2001; Loewenstein et al. 2001). It could also be that since these individuals typically already live in high risk environments, they might not be particularly sensitive about additional risk.

We provide evidence from Italy, a country that is often hit by strong earthquakes (and, suggestively, with a low propensity to entrepreneurship – see for instance World Economic Forum, 2016 –). We exploit, in particular, the high heterogeneity of seismic events across Italy's territories. By using a dataset that merges individual-level data on preferences and occupations (from the Bank of Italy Survey of Household Income and Wealth, SHIW) with information on earthquakes from the National Institute of Geophysics and Volcanology (Rovida et al., 2016), we document through our first-stage estimations that individuals exposed to an earthquake in the past are characterized by higher present levels of risk aversion. This result is robust when controlling for a long list of individual and local-level covariates. Moreover, the exposure to a seismic event affects more intensively the preference for risk when it comes at the time the individual is young (in the so-called "impressionable years") and preferences are more malleable (Giuliano and Spilimbergo, 2013).

While the impact of earthquakes on risk preferences is interesting on its own, the feasibility of using the variation in risk aversion driven by natural disasters as an exogenous determinant of entrepreneurship must satisfy additional requirements. First, the preference shock has to precede the decision to become or not an entrepreneur. In this regard, we make sure that in our sample the traumatic experience of an earthquake comes before of any potentially omitted determinant of occupational choice.

Moreover, in the aftermath of an earthquake local economic activity might be severely damaged. Within weeks, however, the local economy might receive a significant amount of public transfers intended for reconstruction and recovery. This is particularly relevant in our setting as entrepreneurship in Italy has an important local dimension (the fraction of entrepreneurs working in the region where they were born is significantly higher than the corresponding fraction for dependent workers, see Michelacci and Silva, 2007). Thus, the likelihood of entering into entrepreneurship might be affected by destruction/recovery dynamics. To warrantee that our instrument is correlated with the outcome variable solely through its correlation with risk aversion (our exclusion restriction) we only consider earthquakes experienced in the distant past (10 or 20 years before the decision to become an entrepreneur) therefore excluding those for whom the post-natural disaster destruction/recovery dynamics might be still going on.

We find a negative impact of risk aversion on the probability of being an entrepreneur. Our preferred specification suggests that an increase of one standard deviation in risk aversion reduces the probability of becoming an entrepreneur of about 10 percentage points. Comparing our IV estimates with their OLS counterparts, we highlight that measurement error and omitted variables that positively affect both entrepreneurship and risk aversion might be the relevant sources of econometric pitfalls.

Our findings are corroborated by an extensive robustness analysis. We show that endogenous sorting of residents driven by their risk aversion is not an issue for our investigation. We also document that our results do not rely on some admittedly arbitrary choices, as for the definition of entrepreneur and the extent to exposure to seismic events.

The paper is structured as follows. Section 2 describes the related literature. The data are illustrated in Section 3. Section 4 presents the IV estimates for the impact of risk preferences on the likelihood of entering entrepreneurship. A full-fledge robustness analysis is provided in Section 5. The last section concludes.

2. Related Literature

Individual risk preferences have long been considered as a crucial personal trait of entrepreneurs (Knight, 1921; Kihlstrom and Laffont, 1979). However, the empirical literature investigating the relationship between risk attitudes and entrepreneurship is much more recent, mainly because of the lack of data providing direct measures of risk preferences. Early studies, relying on indirect measures of risk preferences based on risky behavior (such as health insurance coverage, seat belt use, harm avoidance, smoking and drug use), reached mixed results. Tucker (1988) finds no effects of risk attitudes on being self-employed, while Fairlie (2002) and Francis and Demiralp (2006) find a positive correlation. Ekelund et al. (2005) find that their measure of risk aversion is negatively correlated with the individual's probability of being self-employed.

In the last two decades a number of surveys, such as the German Socio-Economic Panel (GSEP), the National Longitudinal Survey of Youth (NLSY) for US and the Survey on Household Income and Wealth (SHIW) for Italy, have started to include questions aimed at eliciting direct measures of risk preference. For example, the NLSY includes questions on risk aversion starting from 1993, while the GSEP pose questions on risk preferences starting from 2004. These questions typically ask individuals to choose the amount of money they would like to invest in a risky hypothetical lottery or ask them their general tendency to take risks. Using these direct measures of risk aversion, a number of empirical investigations have established a positive correlation between individual willingness to take risks and the probability of being self-employed (Van Praag and Cramer, 2001; Cramer et al., 2002; Ekelund et al., 2005; Fossen, 2011; Hvide and Panos, 2014).

Other studies use incentive-compatible measures of risk attitudes, which might help at dealing with problems faced by measures based on survey questions (inattention, self-serving biases, etc.), also finding mixed results. For instance, while Koudstaal et al. (2015) show that even if entrepreneurs perceive themselves as less risk averse than managers and employees, when using experimental incentivized measures, the differences are subtler. Holm et al. (2013) find that entrepreneurs do not differ from other people as regards behavior under uncertainty, however, they are more willing to bear uncertainties involving a strategic risk. Macko and Tyszka (2009) provide evidence of more risky choices among entrepreneurs than among non-entrepreneurs. On the other hand, a number of papers demonstrate that survey data are quite good predictors of actual risk taking behavior in lottery experiments (Dohmen et al., 2011; Lönnqvist et al., 2015; Chuang and Schechter, 2015).

Since in many previous papers preferences are revealed after the decision to enter business, it could be that the self-employment experience makes individuals more willing to take risks. Caliendo et al. (2009) avoid reverse causality problems using risk attitudes measured in the 2004 wave of the German Socio-Economic Panel Study (SOEP) to predict the respondents' transition into self-employment in 2005. They show that risk attitudes have an impact on the choice to enter self-employment for formerly employed individuals, but matter little for transitions from unemployment or inactivity to self-employment. Brown et al. (2011) also document that risk preferences measured in the 1996 wave of the Panel Study of Income Dynamics (PSID) are positively correlated with self-employment nine years later. Similarly, using data from the NLSY panel, Ahn (2010) finds that relative risk tolerance measured in 1993 and 2002 has a positive impact on the probability of entering self-employment in the following years.

However, this evidence can still be hardly considered as proof of causation as it might be driven by unobserved factors that influences both the decision to become self-employed and risk attitudes. A factor that is likely to affect both risk preferences and the decision to become an entrepreneur is the influence of parents (for instance, through inheritance, information transmission etc.). To isolate the impact of risk preferences from the impact of parental background on the decision to start a new business, Skriabikova et al. (2014) exploit a historical setting in which the second channel is mainly shut down. More precisely, they consider that, due to the banishing of self-employment by the communist regime in Ukraine, individuals who grew up under that regime had not the possibility to observe their parents involved in entrepreneurship activities and, as a consequence, the intra-family transmission of self-employment experiences could not take place. They find a strong positive correlation between risk preference and self-employment after transition that in their setting is unlikely to be driven by parents transmitting self-employment experience. However, as the authors admit, it could still be that other potential omitted factors affect both risk attitudes and the self-employment decision.

In this paper we try to shed some light on the causal impact of risk preferences on the choice of being an entrepreneur by exploiting the exogenous variation in risk preferences produced by the exposure to a natural disaster. We rely on the growing literature that investigates how the negative shock deriving from a natural disaster or a violent conflict influence individuals' risk preferences.

Cameron and Shah (2015) is one of the first studies analyzing the impact of natural disasters on risk preferences. They conduct a number of risk games with randomly selected individuals in Indonesia and find that individuals in villages that recently suffered a flood or earthquake exhibit higher level of risk aversion than similar individuals living in villages that did not experience a disaster. A greater risk aversion after a natural disaster is also found by Cassar et al. (2011) who conduct a series of experiments to examine the impact of the 2004 Asian tsunami on the risk taking behavior of individuals in Thailand. A positive impact on risk propensity is instead found by Eckel et al. (2009) and by Hanaoka et al. (2018) who investigate the effects on risk taking behavior of the Hurricane Katrina and the Great East Japan Earthquake, respectively. Similar results are found by Page et al. (2014) who consider the 2011 Australian floods as a natural experiment and show that homeowners who were victims of the floods and face large losses in property values are much more likely to opt for a risky gamble.[1]

A number of other papers exploit instead exposure to traumatic events such as violence (Callen et al., 2014; Jakiela and Ozier, 2018; Moya, 2018) and loss of relatives (Bucciol and Zarri, 2015) to investigate changes in attitudes toward risk and in risk taking behaviors.

[1] Bernile et al. (2017) examine the relation between CEO early-life exposure to fatal disasters and the subsequent corporate financial and investment policies they adopt. They show that CEOs who have suffered very negative effects from natural disasters behave more conservatively, while CEOs who have experienced disasters without extremely negative consequences lead firms that behave more aggressively.

3. Data and Descriptive Statistics

3.1. Bank of Italy Survey of Household Income and Wealth (SHIW)

We use data taken from different sources. First of all, we use data at the individual level that derive from the Bank of Italy Survey of Household Income and Wealth (SHIW) which is conducted every two years since mid-60s. It represents one of the most comprehensive surveys used to study economic and social behavior at the household level in Italy (details on the survey can be found in Brandolini and Cannari, 1994). Almost 8,000 households – representative of the resident population – are interviewed in each wave allowing us to get information on the personal and demographic characteristics of the individuals of each household (gender, age, educational qualifications, marital status and place of residence) and on their working activity (employment status, type of occupation, industry, earnings and wealth).[2] More importantly, since 2004 it provides information on risk preferences. We use the six waves available until reference year 2014 (2004, 2006, 2008, 2010, 2012, 2014) with about 8,000 households interviewed in each year.

Our main measure of risk aversion is based on the following question asked to the head of the household: "In managing your financial investments, would you say you have a preference for investments that offer: 1) very high returns, but with a high risk of losing part of the capital; 2) a good return, but also a fair degree of protection for the invested capital; 3) a fair return, with a good degree of protection for the invested capital; 4) low returns, with no risk of losing the invested capital.[3] We build the variable *Risk Aversion* as a categorical variable going from 1 to 4, where 1 is for individuals preferring high returns and high risk (i.e. less risk averse) whereas a value of 4 is for individuals preferring low returns and no risk (i.e. more risk averse). We also use a dummy variable *Risk Averse* that is set equal to 1 for individuals choosing to incur no risk at all (*Risk Aversion*=4) and 0 otherwise. All data refer to the head of the household and we drop the observations for the other members of the family since we do not observe their risk attitudes.

Although this measure is referred to a specific type of risk, it seems quite reliable and behaves accordingly to the results emerging from a number of recent papers on the subject. In particular, as many papers in the literature (see Nelson, 2015, for a survey), we find that women are more risk averse than men (+0.135, *t*-stat=11.0; for this and following results, we refer to Table A1 in the Appendix, col. 3). Evidence consistent with the literature is also found when looking at age, education and family background (Golsteyn et al., 2014; Dohmen et al., 2017): risk aversion increases with age (+0.003, *t*-stat=6.1), individuals with a higher level of education tend to be less risk averse than less educated respondents (-0.03, *t*-stat= -18.7) and individuals with more educated parents tend to be less risk averse

[2] The reference person is identified with the person responsible for the household budget (or most knowledgeable about it).

[3] The US Survey of Consumer Finances includes a similar a question.

than respondents whose parents have a lower level of education (not reported). Family wealth strongly reduces risk aversion (-0.00026; t-stat=-9.9, see column 5 in Table A1).

In addition, using data from the 2010 wave we have built an Arrow–Pratt index of absolute risk aversion based on a question asking individuals to choose the amount of money they would like to invest in a hypothetical lottery based on the toss of a coin, where there is the chance to double the invested money, but where it is equally possible to lose half of the amount invested.[4] We find a positive (0.20) and highly statistically significant (*t*-stat=10.9) correlation between the Arrow–Pratt index of Risk Aversion and our variable *Risk Aversion.*[5] Unfortunately, this measures is only available for the 2010 wave and presents a quite large number of missing values (about half of the sample, leaving us with 3584 obs.), which coupled with the fact that in our dataset only 3% of respondents are entrepreneurs makes it not suitable for the aim of our analysis.

In our main analysis we consider as "Entrepreneur" those individuals who declare to be an "individual entrepreneur" or "manager and shareholder (or partner) of societies" or who were in one of these conditions before retiring.[6] In the robustness section, we show that our results remain qualitatively unchanged even if we take a more conservative definition of entrepreneur, as to exclude the "manager/shareholder/partner" respondents, whose risk exposure might be more doubtful.

3.2. Seismic events and seismic hazard in Italy

A second source of data we use is on seismic events. Italy is one of the countries in the Mediterranean with the highest seismic risk. The reason is that the country lies where the African and Eurasian tectonic plates converge (they are moving together at a rate of 4-10mm a year). Our main source of information is the catalogue of Italian earthquakes provided by the *National Institute of Geophysics and Volcanology* (INGV) since the year 1,000 (Rovida *et al.*, 2016). Available information include: date, the exact latitude and longitude of the epicenter, depth, and size (measured in Moment Magnitude scale, Mw). From 1900 to 2014 were recorded 2,596 seismic events classified as superficial (i.e. depth between 0 and 70 km), which can be potentially perceived by the local population.[7] Figure B1 in the Appendix shows the distribution of earthquakes by their size (Mw).

[4] More precisely, individuals are asked the following question: "Imagine you can take part in a lottery in which for every euro invested, you can either double your money (win 1 euro) or lose half of it (lose 50 cents), depending on the toss of a coin (tails you win, heads you lose). How much money would you invest?".
[5] A positive and highly statistically significant correlation is found also between *Risk Aversion* and a dummy variable *Refuse Investment* which takes the value of 1 for respondents who refuse to invest any money and 0 otherwise.
[6] We do not consider "craftsmen/professionals" and "workers of family firms" as entrepreneurs since even if they are self-employed they are not employers of other workers and their risk bearing is limited.
[7] The median depth of earthquakes events is 10km.

The Moment Magnitude scale (Mw) is a measure of the energy released by earthquake events,[8] which might be only partially informative as regards the intensity of an earthquake as experienced by the residents. Conversely, the Mercalli Intensity Scale measures earthquakes intensity in terms of *effects* produced on people, human structures, and the natural environment. The modified version of the Mercalli Intensity Scale deals with the way in which the earthquake is felt by people by classifying seismic events on a scale that goes from weak (I, Not felt; II, Weak…,) to intermediate (IV, light; V, moderate…,) and to strong (VII, very strong; VIII severe; ….; XII, extreme).[9]

We identify 39 massive seismic events that hit Italy since 1900 and are classified as at least "very strong" earthquakes using the Modified Mercalli Intensity scale: they have a size equal or greater than 5.7 Mw. These earthquakes at minimum caused (from negligible to substantial) damages in buildings. In addition, across this group, death and injury in earthquakes were very frequent.[10] For robustness purposes, in our analysis we also consider the Mercalli's categories of medium earthquakes (size between 3.7 and 5.6 Mw).

Table B1 in the Appendix lists the 39 seismic episodes used in this paper. This table suggests a significant heterogeneity in the territorial distribution of disruptive earthquakes occurred in Italy since 1900: 14 regions out of 20 were hit. The highest seismicity is concentrated in the central-southern part of the peninsula, along the Apennine ridge, in Calabria and Sicily and in some northern areas, like Friuli and Liguria.[11]

We also make use of the seismic hazard map released by the Italian Civil Protection Department (2015). This indicator is based on historical analysis of frequency and size of seismic events and allows to classify Italian municipalities in terms of seismic risk in a scale going from 1 (least dangerous areas, earthquakes are rare) to 4 (most dangerous areas, with very strong probability of earthquakes occurrence).[12] Figure B2 in the Appendix illustrates the seismic hazard map of Italy showing also (with black circles) the place of the 39 major seismic events identified as massive earthquakes since the 1900s.

3.3. Merging Individual and Earthquakes Data

[8] The Moment Magnitude scale is a development of the Richter scale. For medium-size earthquakes events (the vast majority in our case), the size of earthquakes measured by the Moment Magnitude scale or by the Richter scale basically does not differ (see Hanks and Kanamori, 1979).

[9] The relation between the size of earthquakes and Mercalli scale categories commonly adopted is detailed for example here: https://earthquake.usgs.gov/learn/topics/mag_vs_int.php

[10] To identify level VII of the Mercalli scale we use the limit of 5.7 Mw (and not of 6.0 Mw as required by standard classification) to take into account the measurement error of 0.25 Mw suggested by Rovida et al. (2016).

[11] The most destructive earthquake ever occurred from the 1900s in Italy is the one that hit the regions of Sicily and Calabria in 1908 when a 7.1 Mw sized earthquake caused 90,000 victims in the two cities of Messina and Reggio Calabria. In more recent years, a strong earthquake occurred in Irpinia-Basilicata (1980), with almost 2,600 individuals having lost their lives. In 2009 another earthquake has struck Umbria with 309 victims, 1,600 injured, and about 80,000 displaced people.

[12] We inverted the original scale.

In the SHIW we have information on the municipality in which each household lives but we are unable to uncover the municipality in which individuals lived in the past, then to limit measurement errors, we only consider individuals currently living in the province in which they were born and exclude all the other individuals (observations reduce from 48,000 to 36,000). Using the information on the place of residence we build the dummy variable *Earthquake* taking the value of one for individuals that after age 18 have been exposed to a strong earthquake (greater than 5.7 Mw) near the place of residence (if the place of residence is within 50 km from the epicenter) [13] and zero for those who have never experienced an earthquake or for those who have experienced weak or intermediate earthquakes (that is, below 5.7 Mw). We have also experimented considering the occurring of earthquakes since individual birth, after age 10 and in the range 18-30 years old.

Moreover, we have built two additional variables to define earthquake experiences: *Intermediate Earthquake* which takes the value of one for individuals experimenting an intermediate earthquake (greater than 3.7 Mw and smaller than 5.7 Mw) and zero otherwise; *Distant Earthquake: 51km-150km* for individuals experimenting strong earthquakes in a place that is distant from 51 to 150 km from the epicenter and zero otherwise.

Table 1 reports summary statistics of the main variables used in our analysis. On a scale from 1 to 4, Risk Aversion is on average 3.37 and about half (52%) of the individuals are highly risk averse (0/1). 4.4% experimented a massive earthquake. 33% live in municipalities with high seismic hazard (index=3), while 43% of them live in municipalities with medium seismic hazard (index=2).

About 3.4% are (or have been) entrepreneurs. Women are 31% of our sample. Mean age is 57 (48% of individuals in our sample are currently retired). Average years of education are 9.9. 46% of the individuals in the sample are from North, 23% from Centre, 30% from South.

[Table 1]

4. Entrepreneurship and Risk Aversion: IV Estimates

A number of empirical difficulties are faced when trying to assess the impact of individual risk aversion on the probability of becoming an entrepreneur. First of all, many omitted variables could affect both risk aversion and the entrepreneurial choice, for example, family wealth, individual ability, and so on. Secondly, working conditions are likely to affect risk preferences giving rise to a reverse-causality problem. Finally, there could be a measurement error since the proxy for risk preferences is taken from a survey and derives from responses to a hypothetical question on financial choices. This measure might capture only partially the type of risk that matters for business ventures.

Our identification strategy is to use an IV estimation strategy exploiting as a source of exogenous variation for risk aversion the experience of an earthquake. As surveyed in Section 2, a

[13] A radius of 50 km roughly corresponds to the “crater”, which is the area damaged from a given seismic episode.

number of recent papers show that natural disasters affect individuals' risk attitudes and that these effects are likely to persist over time (Cassar et al., 2011; Hanaoka et al., 2018).

We make sure that in our sample the traumatic experience of an earthquake comes before of any potentially omitted determinant of occupational choice. In fact, area-level changes in access to entrepreneurship due to post-earthquake dynamics might bias our results. Therefore, to lend credibility to our exclusion restriction, we only consider individuals that were exposed to a strong earthquake at least 10 years before the beginning of their current job (we exclude from our estimates individuals experimenting an earthquake afterwards).

While 10 years seem to be a reasonable amount of time for the recovery activity to be over, we also experiment, as a robustness check, a more stringent condition, by only considering earthquakes taking place at least 20 years before the current occupational choice.[14]

In Table 2 we report instrumental variable estimation results of the effect of risk aversion on the probability of being an entrepreneur. Standard errors are robust to heteroscedasticity and are allowed for clustering at the household level to take into account that a number of individuals has been interviewed more than once. We weigh observations using weights that denote the inverse of the probability that the observation is included because of the sampling design.[15]

In Panel B of Table 2, we report First-Stage estimation results, for the impact of experiencing a strong earthquake (events with a size equal or greater than 5.7 Mw) on individual's risk attitudes, measured with a scale from 1 (low risk aversion) to 4 (very high risk aversion). This impact is estimated to be positive in all specifications: experiencing an earthquake increases risk aversion by about 0.12 units in a 1-4 scale (or about 0.16 SD). The instrument is not "weak" since the F-statistics are always well above the threshold of 10 (Staiger and Stock, 1997).

For a more detailed discussion of the impact of being exposed to an Earthquake on risk attitudes see the estimation results reported in Table A1 in the Appendix of the paper. [16]

Panel A of Table 2 presents Second Stage estimates. The first column examines the effect of risk aversion on the probability of being an entrepreneur, without other controls. We find that an increase of one Standard Deviation (0.746) in *Risk Aversion* reduces the probability of being an entrepreneur by about 6.5 percentage points (*t*-stat=4.35). In column (2) we add controls for gender, age, education, and dummies for the area of residence (North, Central, or Southern Italy). We find an even stronger negative effect of our measure of risk aversion on the probability of being an entrepreneur (-8.8 p.p. for 1 SD increase). We also find that the likelihood of entering into entrepreneurship is lower for highly educated

[14] We are very conservative on this issue, especially considering that Porcelli and Trezzi (2018) for Italian provinces find that the impact of earthquakes on output and employment tend to be small or negligible. Moreover, they find that the effects are non-persistent and are reabsorbed within 2 years.

[15] Our results are however rather insensitive to using the survey weights.

[16] From the first stage equation, analyzing the impact of Earthquakes on risk aversion measured using the Arrow–Pratt index of absolute risk aversion, we find results that are similar to those reported in the paper.

respondents, while residents in the central regions of Italy (the reference category) display the highest propensity. The Coefficient on *Female* turns out to be not significant.[17]

In Column (3) we add an indicator for those who are currently retired; we also control for survey-year dummies, city-size dummies (which suggest that population density positively impacts on entrepreneurship), and seismic hazard dummies (4-level seismic hazard of each municipality as measured by the Italian Civil Protection Department, see Figure B2). Including seismic hazard dummies allows us to estimate the impact of an earthquake for individuals living in areas with the same level of seismic hazard, that is, it allows to control for the extent to which our results are effected by endogenous sorting. Crucially, controlling for seismic hazard reduces the first-stage F statistic only modestly, while it does not affect our IV estimate of the impact of risk aversion on entrepreneurship: the point estimate increases from -0.12 to -0.15, remaining highly significant.[18]

Evidence suggesting that endogenous sorting is not a major issue in our analysis derives also from the fact that if individuals with higher levels of risk aversion sort into areas with a lower risk of natural disasters, our first-stage should lose power (insofar earthquake risk is already taken onboard), which does not seem to be the case in our data.

In addition, if natural disasters affect individual migration decision in relation to preferences for risk we might expect that areas with high seismic hazards are populated by individuals with a stronger preference for risk (less risk averse individuals should be more likely to move in more secure regions). In other words, if risk-averse individuals after an earthquake tend to move to areas with a low seismic risk this would tend to generate a negative correlation between seismic hazards and risk aversion. However, in our sample, when using individual controls, we do not find any statistically significant difference in attitudes toward risk according to the seismic hazard of the municipality of residence.

In column (4), to take into account the impact of kinship involvement in business and inheritance, we add the dummy variable *Father Entrepreneur* (this inclusion reduces the observations to 21,945 because of several missing values as regards fathers' job). While the effect of a father entrepreneur on individual own propensity to be an entrepreneur is positive and strong (+17 p.p.), the impact of risk aversion remains undisputed.

In order to take into account the effect of wealth on the probability of entering business, in column (5) we also control for the value of an individual's net assets. Even if our measure of family wealth is probably endogenous, it is correlated with initial wealth, which may affect the entrepreneurship decision (this is especially true for the Italian economy, characterized by low intergenerational mobility).

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[17] While the proportion of female entrepreneurs is much lower than that of male entrepreneurs, when one controls for risk-aversion and for education the gender difference tend to become not significant.

[18] We have also tried to model the probability of being a mover (that is, living in a province that differs from the province of birth). We find that risk aversion tends to be negatively correlated with the probability of moving. As regards the relationship between the probability of moving and earthquake occurrence at the provincial level, we find a negative effect. However, the interaction term between earthquake exposure and risk aversion is about zero and far from statistical significance.

We find that wealth is positively correlated with the decision to become an entrepreneur but the inclusion of this variable does not produce any relevant change in our findings.

Finally, in column (6) we add among our regressors also an indicator of the stance of the local business cycle, as proxied by the provincial GDP. The latter seems to have a negative impact on entrepreneurship, but does not change the effect of risk aversion on our outcome variable.

As a comparison of our IV estimates in Panel C of Table 2 we report OLS estimates. We find a negative and significant relationship between risk aversion and entrepreneurship, but the magnitude of the coefficients tend to be a small fraction of the IV estimates. Comparing the OLS results with the IV estimates of Panel A, we note an upward bias in OLS estimates, implying that some omitted factors that positively (negatively) affect entrepreneurship are also positively (negatively) correlated with risk aversion. Measurement error, which leads to an attenuation bias, is the other potential relevant candidate to explain the bias in the OLS estimated relationship between risk attitude and entrepreneurship.

[Table 2]

5. Robustness and Extensions

In this Section we present a set of robustness checks that we have conducted to verify if our results hold true when we modify several choices and criteria adopted in our baseline estimates.

First of all, we take into account that risk aversion tend to be correlated with intertemporal preferences (Vereshchagina and Hopenhayn, 2009; De Paola, 2012). We take advantage of a question, included in some of the SHIW waves to a fraction of the heads of household (our sample reduces to about 13,000 observations), asking in a hypothetical financial situation how much money they would give up in order to receive a certain amount of money today instead of in one year's time.[19] We use answers to this question to build a measure of time preference, *Impatience*, that we use as additional control in our regressions.[20]

First Stage results (not reported) show that *Impatience* is positively correlated to risk aversion. Nonetheless, as reported in Table 3 (we estimate the same specifications of Table 2), even when controlling for impatience, the effect of risk aversion on Entrepreneurship remains negative and quite stable (to save space, coefficients on control variables are not reported).

[19] To be more precise, respondents are asked the following question: "You have won the lottery and will receive a sum equal to your household's net yearly income. You will receive the money in a year's time. However, if you give up part of the sum you can collect the rest of your win immediately". The available alternatives regarding the percentage of the sum that respondents would be willing to give up are 0, 2, 3, 5, 10 or 20 percent.

[20] We have checked whether experimenting an earthquake affects individual intertemporal preferences and we found that an earthquake tends to increase impatience only in a very simple regression. However, when we use individual controls the effect of an earthquake becomes not significant corroborating the evidence that measures of time preferences are relatively stable over time (Meier and Sprenger, 2010; Wolbert and Rield, 2013).

[Table 3]

Next, instead of using as a measure of risk aversion the four-scale variable *Risk Aversion*, we use the binary variable *Risk Averse 0/1* (which takes the value of one for respondents who prefer investments with low returns and no risk). The First Stage results (not reported) are similar to previous estimates: an earthquake increases of about 7-8 p.p. the probability of becoming risk averse. Second Stage estimates (Table 4) show that individuals who prefer to bear no risk are significantly less likely to end up as entrepreneurs: the probability is reduced of about 25 p.p. in specifications with the full set of controls.

[Table 4]

While, in our baseline estimates we have restricted the sample to individuals experimenting an earthquake at least 10 years before their current occupational choice, to be more conservative and strengthen our exclusion restriction, in Table 5 we only consider individuals experimenting an earthquake at least 20 years before they started their current job. Results are very similar to our baseline estimates.

[Table 5]

In Table 6 we exclude individuals that are currently retired (that we have considered in previous estimates in order to increase the sample size). We find similar results, although the standard errors are now much higher because of the considerable lower number of observations.

[Table 6]

Whereas in our main estimates we classified as entrepreneurs both pure entrepreneurs and "managers and shareholder/partners", we now use a more restrictive definition of entrepreneur considering only the first category. The corresponding estimates are reported in Table 7. Our main results are again confirmed.

[Table 7]

The SHIW defines the head of household as the person responsible for the household's economic decisions, thus allowing for the presence of female-headed households (about 30% in our sample). Given this particular feature, women present in our sample might not be representative of the whole female population. To be reassured that our results are not driven by this peculiar subpopulation, we have analysed the effect of risk aversion on the decision to become an entrepreneur restricting our sample to males. As shown in Table 8, our main results remain qualitatively unchanged. It comes as no surprise as, in line with existing evidence (see for instance Caliendo et al., 2014), only 13% of entrepreneurs in our sample are women.

[Table 8]

In previous estimates we considered earthquakes hitting individuals after age 18. However, Giuliano and Spilimbergo (2013) referring to some works in the psychological field argue that individual preferences are especially malleable in the "impressionable years", between age 18 and 25. Therefore, we now redefine our variable *Earthquake* setting it equal to one only if individuals experimented an earthquake in the age 18-25, and zero otherwise. We re-estimated specifications in Table 2 using this new variable *Earthquake 18-25*. Unfortunately, we do not have enough variability in our instrument and the first stage *F*-statistics are typically below the threshold of 10 (Staiger and Stock, 1997). We then considered earthquakes occurring in the age 18-30 instead of 18-25. In this case, the *F*-statistic is always above 10 and the second stage IV estimates are reported in Table 9. We find that an earthquake in that age increases risk aversion of about 0.20 points, with an impact that is typically higher than the impact of an earthquake since age 18. As regards the effect of risk aversion on entrepreneurship, we find again a negative effect of about 8-9 percentage points, although in the last columns the effect is measured imprecisely (*p*-values around 0.12-0.13).

[Table 9]

Very similar results are found in Table 10 when we experiment by considering as hit by an earthquake all the individuals who have been exposed to a strong seismic event when they were older than 10. We have also considered, alternatively, those exposed to an earthquake in their life, regardless of age obtaining qualitatively very similar findings (results not reported and available upon request).

[Table 10]

In the main analysis we only considered very strong earthquakes with a Mw higher than 5.7, causing damages to buildings and victims. Moreover, we focus exclusively on earthquakes distant at maximum 50 km from the individual's place of residence. One could wonder if intermediate earthquakes (with a Mw greater than 3.7 and smaller than 5.7, or grades IV, V and VI of the Mercalli scale) which are felt by many people or by everyone but produce only slight damages, have an impact of risk attitude and then on entrepreneurship.

In Table 11 we report TSLS estimates when using as an additional instrument the dummy variable *Intermediate Earthquake*. From the First Stage estimates we find that while the exposure to strong earthquakes has an impact on risk attitude little or no effects are produced by exposure to Earthquakes that have produced no serious damage. Consistently with the evidence provided by Bernile et al (2017), the coefficient on Intermediate Earthquake tends to be negative. Nonetheless, the impact of strong earthquakes remains more or less of the same magnitude and statistical significance as in our main specifications. Second stage estimates remain also unaltered.

[Table 11]

In the same vein, it is worthwhile to investigate if strong earthquakes occurring farther than 50 km have an impact on risk attitude. In Table 12 we consider the dummy variable Earthquake: 51km-150km (for strong earthquakes with an epicenter that is within 50 km from the place of residence) as an additional instrument with respect to strong earthquakes. From first stage estimates (Panel B of Table 12), we find that strong earthquakes in a distant geographical area produce small negative effects on individual attitudes toward risk or the effects are not statistically significant. The impact of strong earthquakes on risk aversion is almost unchanged and so remains the effect of risk aversion on entrepreneurship (Panel A of Table 12).

[Table 12]

6. Concluding Remarks

In this paper we have analyzed the impact produced by risk aversion on the probability of becoming an entrepreneur. In order to identify a causal effect we have adopted an instrumental variables estimation strategy exploiting as an exogenous source of variation in risk attitudes the early individual exposure to a massive earthquake. At this aim we have taken advantage of the high heterogeneity of seismic events across the Italian territories and used a dataset that merges individual-level data on preferences, occupations and municipality of residence (SHIW) with information on earthquakes (National Institute of Geophysics and Volcanology).

We have handled endogeneity and reverse causality problems by focusing on individuals who have been exposed to an earthquake before their occupational choice. In addition, to lend credibility to our exclusion restriction hypothesis (the likelihood of entering into entrepreneurship might be affected by destruction/recovery dynamics), we have focused on earthquakes taking place in a distant past (10/20 years before the occupational choice).

First stage estimation results show that being exposed to an earthquake increases our measure of individual risk aversion by about 0.16 Standard Deviations. The same effect is found also when we control for a number of individual features and for the seismic hazard of the place of residence. Given the mixed results found by previous literature and the absence of evidence for Italy, this finding represents an important evidence in its own right. Our evidence, supporting results found by Cameron and Shah (2015) and Cassar et al. (2017), suggests that natural disaster produce effects that stretch beyond the destruction of buildings and the loss of lives. An increase in risk aversion is likely to affect a number of behaviors that can produce long lasting effects and influence future economic development. While other papers have already recognized this possibility we have taken a step further by providing evidence on the effect that increased risk aversion produces on the probability of opening a new business.

Our second stage estimates highlight in fact a strong negative influence of risk aversion on the probability of being an entrepreneur. The magnitude of the effect is considerable as an increase of one standard deviation in risk aversion reduces the probability of becoming an entrepreneur of about 10-12 percentage points.

This evidence points at the importance of policies aimed at providing assistance and support to people after a natural disaster: these policies in addition to their immediate and direct effects can also indirectly help at enhancing economic growth, by mitigated the impact that disasters can produces on individual attitudes such as risk aversion.

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Table 1. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max	Obs.
Risk Aversion	3.371	0.746	1	4	24,156
Earthquake	0.044	0.205	0	1	24,156
Seismic Hazard Index 1 (least dangerous areas)	0.206	0.404	0	1	24,156
Seismic Hazard Index 2	0.431	0.495	0	1	24,156
Seismic Hazard Index 3	0.333	0.471	0	1	24,156
Seismic Hazard Index 4 (most dangerous areas)	0.029	0.167	0	1	24,156
Entrepreneur	0.034	0.182	0	1	24,156
Female	0.307	0.461	0	1	24,156
Age	57.673	15.031	19	104	24,156
Education yrs.	9.862	4.291	3	20	24,156
North	0.465	0.499	0	1	24,156
South	0.304	0.460	0	1	24,156
Risk Averse 0/1	0.523	0.499	0	1	24,156
Impatience	5.999	6.814	0	20	12,974
Risk Aversion (2)	123.038	266.077	0	1000	2,794
Wealth	271.454	309.459	-767.057	1716.323	24,156
Parents' Education	5.818	2.894	3	20	21,671
Father entrepreneur	0.019	0.135	0	1	21,945
Local GDP	26809.640	7534.519	13400	51000	24,156
Currently retired	0.483	0.500	0	1	24,156
Intermediate Earthquake	0.900	0.299	0	1	24,156
Earthquake 51-150 km	0.484	0.500	0	1	24,156
Earthquake: Age 18-30	0.012	0.110	0	1	24,156

Sources: SHIW 2004-2014 Waves; Earthquakes: National Institute of Geophysics and Volcanology.

Table 2. Risk Aversion and Entrepreneurship. Two-Stage-Least-Squares Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Second Stage			
Risk Aversion	-0.087***	-0.119***	-0.148***	-0.169***	-0.149**	-0.151**
	(0.020)	(0.038)	(0.057)	(0.061)	(0.061)	(0.062)
Female		-0.007	-0.002	0.000	0.005	0.005
		(0.007)	(0.009)	(0.009)	(0.008)	(0.008)
Age		0.000	0.001***	0.001***	0.001	0.001
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education yrs.		-0.004***	-0.005***	-0.007***	-0.008***	-0.008***
		(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
North		-0.013*	-0.015	-0.021*	-0.015	-0.013
		(0.008)	(0.009)	(0.011)	(0.011)	(0.011)
South		-0.023***	-0.025***	-0.031***	-0.020*	-0.033**
		(0.007)	(0.009)	(0.011)	(0.012)	(0.015)
Currently retired			-0.038***	-0.038***	-0.034***	-0.034***
			(0.007)	(0.007)	(0.007)	(0.007)
Father entrepreneur				0.171***	0.148***	0.147***
				(0.030)	(0.028)	(0.028)
Wealth					0.000***	0.000***
					(0.000)	(0.000)
Local GDP						-0.000**
						(0.000)
Constant	0.328***	0.486***	0.565***	0.641***	0.589***	0.624***
	(0.067)	(0.137)	(0.205)	(0.218)	(0.214)	(0.223)
Year dummies	NO	NO	YES	YES	YES	YES
City Size dummies	NO	NO	YES	YES	YES	YES
Seismic Hazard Dummies	NO	NO	YES	YES	YES	YES
Observations	24156	24156	24156	21945	21945	21945
			Panel B: First Stage			
Earthquake	0.262***	0.152***	0.124***	0.129***	0.121***	0.121***
	(0.032)	(0.031)	(0.032)	(0.035)	(0.034)	(0.034)
R-squared	0.004	0.068	0.087	0.089	0.099	0.100
First-Stage F-statistics	66.684	23.701	15.220	13.888	12.469	12.251
			Panel C: OLS Results			
Risk Aversion	-0.006***	-0.005*	-0.004*	-0.005*	0.001	0.000
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Adjusted R-squared	0.001	0.005	0.012	0.030	0.067	0.067

Notes: The dependent variable is *Entrepreneur*. From the sample we exclude individuals experiencing earthquakes in the 10 years before the current occupational choice or after. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 3. Second Stage IV Estimates. Controlling for Impatience

	(1)	(2)	(3)	(4)	(5)	(6)
Risk Aversion	-0.067***	-0.096**	-0.157**	-0.151**	-0.117*	-0.119*
	(0.025)	(0.044)	(0.074)	(0.072)	(0.071)	(0.072)
Impatience	-0.000	-0.000	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	12974	12974	12974	12974	12974	12974

Notes: The dependent variable is *Entrepreneur*. We estimate the same specifications of Table 2, using the same sample restriction. Only waves 2004, 2008, 2010, 2012. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 4. Using the Dummy Risk Averse. Second Stage IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Risk Averse 0/1	-0.133***	-0.206***	-0.273**	-0.285**	-0.253**	-0.256**
	(0.032)	(0.079)	(0.131)	(0.126)	(0.124)	(0.126)
Observations	24156	24156	24156	21945	21945	21945

Notes: The dependent variable is *Entrepreneur*. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 5. Sample: Excluding Individuals Experimenting Earthquakes in the 20 Years Before the Current Occupational Choice or After. Second Stage IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Risk Aversion	-0.078***	-0.114***	-0.128**	-0.163**	-0.140**	-0.141**
	(0.019)	(0.041)	(0.059)	(0.068)	(0.068)	(0.069)
Observations	24038	24038	24038	21836	21836	21836

Notes: The dependent variable is *Entrepreneur*. From the sample we exclude individuals experiencing earthquakes in the 20 years before the current occupational choice or after. We estimate the same specifications of Table 2. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 6. Excluding Retired Individuals. Second Stage IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Risk Aversion	-0.151**	-0.214**	-0.287*	-0.247**	-0.214*	-0.212*
	(0.061)	(0.104)	(0.148)	(0.122)	(0.116)	(0.115)
Observations	12490	12490	12490	11463	11463	11463

Notes: The dependent variable is *Entrepreneur*. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 7. Using a more restrictive definition of entrepreneur. Second Stage IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Risk Aversion	-0.066***	-0.120***	-0.146***	-0.140***	-0.132**	-0.132**
	(0.013)	(0.032)	(0.049)	(0.051)	(0.052)	(0.052)
Observations	24156	24156	24156	21945	21945	21945

Notes: The dependent variable is *Entrepreneur*. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 8. Sample: Only Males. Second Stage IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Risk Aversion	-0.101***	-0.140***	-0.156**	-0.190**	-0.165**	-0.164**
	(0.025)	(0.052)	(0.074)	(0.082)	(0.081)	(0.081)
Observations	16735	16735	16735	15367	15367	15367

Notes: The dependent variable is *Entrepreneur*. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 9. Earthquakes in "Impressionable Years" (Age 18-30). IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Second Stage			
Risk Aversion	-0.078**	-0.069*	-0.101*	-0.091	-0.086	-0.086
	(0.037)	(0.041)	(0.056)	(0.058)	(0.057)	(0.057)
			Panel B: First Stage			
Earthquake Age 18-30	0.250***	0.223***	0.195***	0.204***	0.202***	0.201***
	(0.060)	(0.055)	(0.056)	(0.061)	(0.060)	(0.061)
Observations	24156	24156	24156	21945	21945	21945

Notes: The dependent variable is *Entrepreneur*. The variable Earthquake is set equal to one for individuals experimenting an earthquake in the age 18-30, and zero otherwise. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 10. Earthquakes After Age 10. Second Stage IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Risk Aversion	-0.079***	-0.085*	-0.133**	-0.167**	-0.141*	-0.144*
	(0.029)	(0.046)	(0.064)	(0.073)	(0.074)	(0.075)
Observations	24216	24216	24216	22000	22000	22000

Notes: The dependent variable is *Entrepreneur*. The variable *Earthquake* is set equal to one for individuals experimenting an earthquake after age 10, and zero otherwise. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 11. Risk Aversion and Massive and Intermediate Earthquakes. IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
			Panel A: Second Stage			
Risk Aversion	-0.067***	-0.152***	-0.125**	-0.157***	-0.146**	-0.134**
	(0.019)	(0.045)	(0.050)	(0.058)	(0.060)	(0.057)
			Panel B: First Stage			
Earthquake	0.258***	0.155***	0.123***	0.127***	0.120***	0.119***
	(0.032)	(0.031)	(0.032)	(0.035)	(0.034)	(0.035)
Intermediate Earthquake	0.035	-0.047*	-0.074***	-0.057**	-0.059**	-0.066**
	(0.025)	(0.024)	(0.026)	(0.028)	(0.028)	(0.028)
Observations	24156	24156	24156	21945	21945	21945

Notes: The dependent variable is *Risk Aversion*. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table 12. Risk Aversion and Near and Distant Earthquakes. IV Estimates

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Second Stage						
Risk Aversion	-0.064***	-0.123***	-0.093**	-0.120**	-0.098*	-0.098*
	(0.021)	(0.039)	(0.047)	(0.053)	(0.054)	(0.054)
Panel B: First Stage						
Earthquake	0.244***	0.152***	0.127***	0.131***	0.123***	0.123***
	(0.032)	(0.031)	(0.032)	(0.035)	(0.034)	(0.035)
Earthquake: 51-150 km	0.058***	-0.004	-0.052***	-0.037*	-0.036*	-0.036*
	(0.015)	(0.016)	(0.018)	(0.019)	(0.019)	(0.019)
Observations	24156	24156	24156	21945	21945	21945

Notes: The dependent variable is *Risk Aversion*. We estimate the same specifications of Table 2, using the same sample restriction. Standard errors, corrected for heteroskedasticity, are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

APPENDIX A: Earthquakes and Risk Aversion: First Stage Results

In this Appendix we provide more detailed evidence on the relationship between earthquakes and individual risk aversion. This relationship (the first stage of our IV estimation strategy) is interesting in its own right, given the mixed results found by previous literature and the absence of evidence for Italy (see the literature review in Section 2).

Table A1 describes OLS results for the impact of experiencing a strong earthquake (events with a size equal or greater than 5.7 Mw within 50 Km from the place of residence) on individual's risk attitude. We use all the available data without putting any restriction on the time of occurrence of the earthquake with respect to the occupational choice (results using these restrictions correspond to those of Table 2, panel B, of Section 4). We replicate the same specifications reported in Table 2 with the addition of one specification (column 7) in which we control for *Impatience*. Standard Errors are corrected for heteroskedasticity and allow for clustering at the individual level

In column (1), without using control variables, we find that experiencing an earthquake increases our measure of individual risk aversion of 0.132, which corresponds to about 0.18 Standard Deviation of the dependent variable (*t*-stat=7.5). In column (2), we control for some basic individual characteristics: gender, age, education, geographical residence. We find that the impact of an earthquake is reduced to 0.089 but is still highly significant (*t*-stat=5.2). Consistently with previous literature, we find that women are much more risk averse than men, that age makes individuals more averse to risk, while education strongly reduces risk aversion. Individuals in the North and in the South are less risk averse than individuals in the Center.

In column (3) we include a dummy for each level of *Seismic Hazard Index* and dummies for municipality size and for *Retired*. The impact of experiencing an earthquake remains strong and highly statistically significant, while no clear pattern emerges between seismic hazard and risk aversion.

In column (4) and (5) we include two variables that aim to capture family background, that is, *Father Entrepreneur* and *Family Wealth,* respectively. Again, we find that an earthquake make people less tolerant towards risks. We also find that family wealth reduces risk aversion. In Column (6) we control for provincial GDP (a time-varying variable) and we find that higher GDP reduces risk aversion but again the impact of an earthquake on risk aversion is positive and strong. In column (7) we control for our measure of time preference (*Impatience*) and – in a much smaller sample – we show that there is a positive correlation between impatience and risk aversion. However, the impact of an earthquake on risk aversion remains stable (in this specification we use only about 17,000 observations).[21]

Finally, to further investigate if individual risk attitudes change when experiencing an earthquake, we have exploited the panel component of the SHIW (this approach is used by Hanaoka et al., 2018). In our sample 6,910 individuals (head of the household) are interviewed more than once, for a total of 20,654 observations. However, only for a fraction of individuals (188, corresponding to 803 obs.) we are able to observe our measure of risk aversion both before and after an earthquake.[22] Notwithstanding these severe limitations on available data, we estimate our regressions with individual fixed effects (with and without time varying controls: age, wealth, local GDP). In Table A2 we show that experiencing an earthquake increases individual degree of risk aversion by about 0.18 units (*t*-stat=3.5).

[21] Given the nature of our dependent variable we have also estimated the previous specifications with an Ordered Probit estimator. We find results very similar to the OLS estimates (results not reported to save space). We also use the dummy *Risk Averse* instead of the four-categories variable *Risk Aversion*. We again find very similar results.

[22] In the period covered by our data (2004-2014) two massive earthquakes occurred in Italy: in 2009 in Abruzzo and in 2012 in Emilia Romagna.

Table A1. Risk Aversion and Earthquake. OLS Estimates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Earthquake	0.132***	0.089***	0.071***	0.060***	0.054***	0.054***	0.068***
	(0.018)	(0.017)	(0.018)	(0.019)	(0.019)	(0.019)	(0.022)
Female		0.140***	0.135***	0.136***	0.117***	0.117***	0.115***
		(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.016)
Age		0.004***	0.003***	0.003***	0.005***	0.005***	0.004***
		(0.000)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
Education yrs.		-0.032***	-0.030***	-0.030***	-0.024***	-0.023***	-0.021***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
North		-0.106***	-0.135***	-0.135***	-0.143***	-0.138***	-0.148***
		(0.016)	(0.018)	(0.019)	(0.019)	(0.019)	(0.023)
South		-0.132***	-0.135***	-0.140***	-0.162***	-0.202***	-0.192***
		(0.017)	(0.017)	(0.018)	(0.018)	(0.022)	(0.027)
Currently retired			0.029**	0.028*	0.021	0.020	0.060***
			(0.014)	(0.016)	(0.015)	(0.015)	(0.020)
Father entrepreneur				-0.049	0.020	0.017	0.078
				(0.046)	(0.045)	(0.045)	(0.056)
Wealth					-0.00026***	-0.000***	-0.000***
					(0.000026)	(0.000)	(0.000)
Local GDP						-0.000**	-0.000**
						(0.000)	(0.000)
Impatience							0.004***
							(0.001)
Constant	3.394***	3.539***	3.582***	3.552***	3.514***	3.603***	3.601***
	(0.007)	(0.038)	(0.046)	(0.049)	(0.049)	(0.059)	(0.071)
Year dummies	NO	NO	YES	YES	YES	YES	YES
City Size dummies	NO	NO	YES	YES	YES	YES	YES
Seismic Hazard Dummies (4)	NO	NO	YES	YES	YES	YES	YES
Observations	32682	32682	32682	29375	29375	29375	17491
Adjusted R-squared	0.003	0.071	0.091	0.093	0.102	0.103	0.107

Notes: The Table reports OLS estimates. The dependent variable is *Risk Aversion*. Standard errors (corrected for heteroskedasticity and robust to clusters at the individual level) are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

Table A2. Risk Aversion and Earthquake with Individual Fixed Effects

	(1)	(2)	(3)	(4)
Earthquake	0.246***	0.183***	0.182***	0.181***
	(0.050)	(0.051)	(0.052)	(0.052)
Age		0.014***	0.014***	0.014***
		(0.003)	(0.003)	(0.003)
Wealth			-0.000	-0.000
			(0.000)	(0.000)
Local GDP				0.000
				(0.000)
Constant	3.366***	2.565***	2.578***	2.565***
	(0.006)	(0.155)	(0.155)	(0.205)
Observations	20654	20654	20654	20654
Adjusted R-squared	0.002	0.005	0.005	0.005

Notes: The Table reports OLS estimates with individual fixed effects. The dependent variable is *Risk Aversion*. Standard errors (corrected for heteroskedasticity and robust to clusters at the individual level) are reported in parentheses. The symbols ***, **, * indicate that coefficients are statistically significant, respectively, at the 1, 5, and 10 percent level.

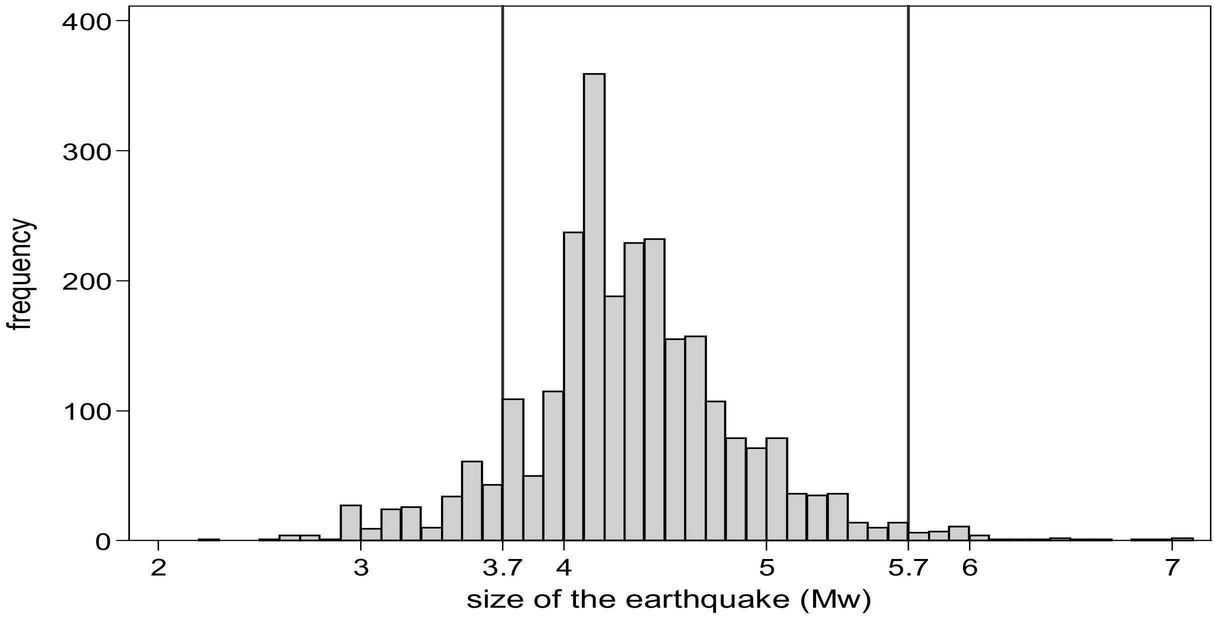
APPENDIX B: Data on Earthquakes

Table B1. List of Massive Earthquakes Hitting Italy since 1900

Year	Epicentral area	Size (Mw)	Location (region)
1905	Calabria central	6.95	Calabria
1907	Aspromonte	5.96	Calabria
1908	Stretto di Messina	7.1	Sicily
1910	Irpinia-Basilicata	5.76	Campania/Basilicata
1915	Marsica	7.08	Abruzzo
1916	Riminese	5.82	Emilia-Romagna
1916	Riminese	5.82	Emilia-Romagna
1917	Alta-Valtiberina	5.99	Tuscany
1918	Appennino-Forlivese	5.96	Emilia-Romagna
1919	Mugello	6.38	Tuscany
1920	Garfagnana	6.53	Tuscany
1926	Carniola interna	5.72	Neighboring country (Slovenia)
1928	Calabria centro-meridionale	5.87	Calabria
1928	Carnia	5.71	Friuli-Venezia Giulia
1928	Carnia	6.02	Friuli-Venezia Giulia
1930	Irpinia	6.67	Campania
1930	Senigallia	5.83	Marche
1933	Majella	5.9	Abruzzo
1936	Alpago-Cansiglio	6.06	Veneto/Friuli-Venezia Giulia
1941	Tirreno meridionale	5.91	Campania
1946	Vallese-Sierre	5.8	Neighboring country (Switzerland)
1962	Irpinia	6.15	Campania
1963	Mar Ligure	5.95	Liguria
1968	Valle del Belice	6.41	Sicily
1976	Friuli	6.45	Friuli-Venezia Giulia
1976	Friuli	5.93	Friuli-Venezia Giulia
1976	Friuli	5.95	Friuli-Venezia Giulia
1978	Golfo di Patti	6.03	Sicily
1979	Valnerina	5.83	Umbria
1980	Irpinia-Basilicata	6.81	Campania/Basilicata
1984	Monti della Meta	5.86	Lazio
1990	Potentino	5.77	Basilicata
1997	Appennino Umbro-Marchigiano	5.97	Umbria/Marche
2002	Tirreno meridionale	5.92	Campania
2002	Molise	5.74	Molise
2002	Molise	5.72	Molise
2009	Aquilano	6.29	Abruzzo
2012	Pianura Emiliana	6.09	Emilia-Romagna
2012	Pianura Emiliana	5.9	Emilia-Romagna

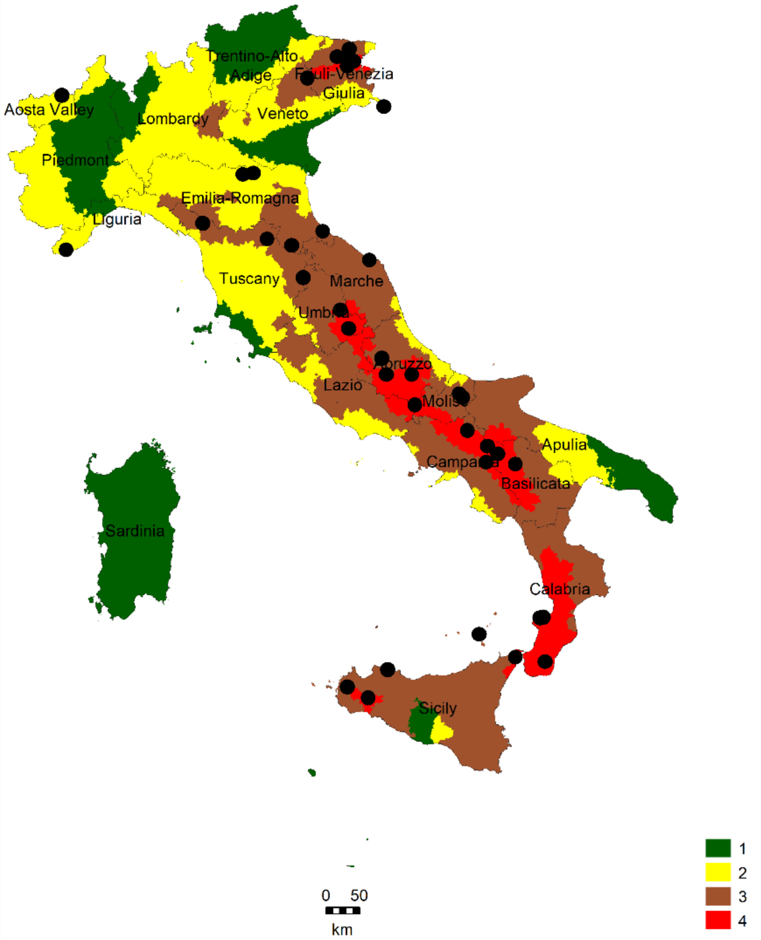
Note: Seismic events of size equal or greater than 5.7 and depth of the epicentral area between 0 and 70 km (superficial seismic events). Source: Author’s elaboration based on earthquakes data from INGV (Rovida et al., 2016).

Figure B1. Seismic Events in Italy since 1900, By Size



Source: Author's elaboration based on Rovida et al., 2016 data. Note: depth of the epicentral area between 0 and 70 km (superficial seismic events).

Figure B2. Seismic Hazard Map of Italy



Source: Author’s elaboration from Italian Civil Protection Department (2015) data. Seismic hazard in a scale from 1 (least dangerous areas) to 4 (most dangerous areas). The figure maps (black circles) the 39 massive earthquake events illustrated in Table B1.